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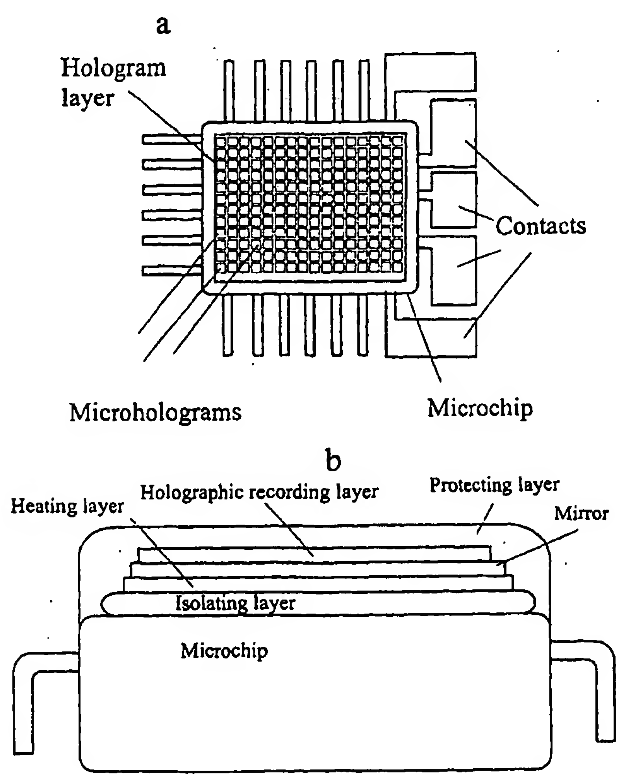
(54) Title: HOLOGRAPHIC CHIP AND OPTICAL SYSTEM FOR THE HOLOGRAPHIC CHIP

(57) Abstract

There is disclosed a semiconductor-based microelectronic device, especially a microchip, provided a holographic storage layer on its optically accessible surface, preferably on its top surface. The invention also includes an optical read-write system for the holographic chip with a holographic layer for polarisation holographic recording. The optical system comprising a read and a write laser, polarising optics, and a programmable display element, for the purposes of modulating the object beam and the reference beam, and a detector array for the readout of the information contained in the holograms of the holographic layer. An image of the programmable display element is recorded in a polarisation recording medium as a single microhologram. The optical read-write system comprises beam scanning means for the purposes of recording and accessing differently located microholograms in the holographic layer. It is foreseen to use the optical system of the invention with a chipcard comprising the holographic chip.



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HOLOGRAPHIC CHIP AND OPTICAL SYSTEM FOR THE HOLOGRAPHIC CHIP

Technical Field

The invention relates to a microchip with an improved memory, and further to an optical system for use with the device.

Background Art

The so-called smart cards, i. e. cards with a built-in microchip have been known for some time. The microchip in the card is capable of performing various "intelligent" functions, like banking functions or medical record functions. The number of these smart card applications is growing steadily.

Practically all applications involve the recording, storage, and transfer of information, mostly some well-defined binary data between the smart card and its host device. Therefor, the microchip or the card needs to store a certain amount of data. This data may be stored in the chip itself, or there are other storage methods, like a magnetic strip.

However, these storage methods are not always adequate. The storage capacity of the chip itself is rather limited. A magnetic strip is rather unreliable, and often loses the stored information due to unexpected strong magnetic fields. It has been proposed to use optical storage methods, but these require optical quality surfaces on a relatively large surface of the cards, which is difficult to realise with the common plastic-based card technologies.

There are some applications where the storage capacity of a known microchip is not sufficient, but the requirements of everyday use do not allow to convert the whole surface of the smart card into an optical storage surface.

Therefore, it is proposed to use a relatively small area only for the data storage. However, in order to utilise this small area, a volume or area efficient storage method is needed. Therefore, it is proposed to incorporate a holographic storage

layer in the smart card, but in a way that is easy to manufacture, and at the same time provides an appropriate environment for a sensitive holographic layer.

The invention is based on the recognition that the holographic layer need not have a large area or volume, but it needs a relatively rigid foundation to keep the layer optically plane for high-density data recording. It has been realised that the most appropriate place for a holographic layer is the built-in microchip of the smart card.

Summary of the Invention

According to the invention, there is provided a semiconductor-based microelectronic device, especially a microchip, which comprises a holographic storage layer on its optically accessible surface, preferably on its top surface. This inventive arrangement provides several advantages. First, the silicone wafer provides an ideally flat and rigid substrate for the hologram, instead of a more deformable plastic carrier. The production of the holographic layer is easy to integrate into the chip manufacturing process, so the embedding of the chip and the hologram on the plastic substrate of the smart card is made in a single process step. and no extra process step is needed to put the holographic layer on the smart card.

Since there is a need for recording and erasing the date several times, it is suggested to use a holographic recording method based on a rewritable holographic medium. especially a so-called SCP medium. Good signal-to-noise rations may be reached in this material using polarisation holography.

Accordingly, the invention also includes a card provided with the microelectronic device of the invention, especially a smart card containing a holographic chip. This type of card will be called hereafter a holographic chipcard. Such a card offers several advantages as compared with the traditional chip-based smart cards. Firstly.

the data storage capacity is increased, so that the services of the card may be improved or extended. Beside, the card is essentially as rugged as a traditional card, because usual amounts of bending and deformation will not affect the optical properties of the hologram. Experience shows that with proper error correction algorithms the readout and write systems will tolerate the usual amount of scratches, to which the holographic layer is subjected. Also, due to its small size and the rigidness of the substrate, it is easier to provide the hologram with a harder, more scratch-resistant protective layer.

In order to read and write data to the hologram on the card, there is needed a compact and cheap solution for the read-write optical system. According to the invention, it is proposed to use an optical read-write system for a holographic layer suitable for polarisation holographic recording, comprising a read laser and a write laser, polarising optics, and a programmable display element, especially an SLM, for the purposes of modulating the object beam and the reference beam. According to the invention, there is provided a single, two-dimensional programmable display element for the modulation of the reference and the object beams.

It is further proposed, according to the invention, to use an optical read-write system for a holographic chip with a holographic layer for polarisation holographic recording, the optical system comprising a read and a write laser, polarising optics, and a programmable display element, especially an SLM, for the purposes of modulating the object beam and the reference beam, and a detector array for the readout of the information contained in the holograms of the holographic layer, where an image of the programmable display element is recorded in a polarisation recording medium as a single microhologram, and further the optical read-write system comprising positioning means for positioning the image of the programmable display element in different positions in the holographic recording layer. To avoid the costly mechanical positioning means, it is suggested to use beam

scanning means for the purposes of recording and accessing differently located microholograms in the holographic layer.

Advantageously, the beam scanning means comprises a scanning mirror or a variable liquid crystal microprism.

In order to increase the recording efficiency, it is suggested to utilise a holographic recording layer structure, especially a layer structure containing an SCP holographic layer, with a heating layer in the vicinity of the holographic layer, in order to heat the holographic layer to optimal operation temperature.

The overall performance of the holographic system is further improved by the use of a holographic recording layer structure suitable for polarisation holography, especially a layer structure containing an SCP holographic layer. In a novel arrangement, this layer structure comprises a homogeneously polished glass sheet, a directionally polished glass sheet, and a liquid crystal layer positioned between the two glass sheets, and further the holographic recording layer positioned between the liquid crystal layer and the homogeneously polished glass sheet, and further the directionally polished glass layer positioned on the other side of the liquid crystal layer.

Finally, the invention also includes a holographic chipcard system, comprising a card with an embedded microelectronic device according to a first aspect of the invention, and further comprising a holographic read-write optical system according to an other aspect of the invention.

<u>Brief Description of Drawings</u>

The invention will be explained more in detail with reference to the accompanying drawings. The drawings illustrate some non-limiting embodiments of the inventive concept.

Fig. 1a is a schematic top view of the holographic chip according to the invention,

Fig. 1b is a schematic cross section of the holographic chip of Fig. 1a,

Fig. 2a is a schematic layout of the optical system according to the invention, for use with the holographic chip of the invention,

Fig. 2b is an enlarged view of the SLM of the optical system of Fig. 2a,

Fig. 3 is a schematic layout of an alternative embodiment of the optical system of the invention,

Fig. 4 is a schematic layout of a further alternative embodiment of the optical system of the invention,

Fig. 5 is a block diagram of the system of the invention including a holographic chipcard and a read-write optical system for the holographic chipcard.

Fig. 6 is an exploded, perspective view of an inventive layer structure used in the holographic chip of the invention.

Best Mode for Carrying out the Invention

Fig. 1a and 1b illustrates the structure of the holographic chip of the invention. The holographic chip is essentially a known semiconductor-based microchip, especially of the type used in so-called smart cards. The microchip is provided with a holographic recording layer on its top. The holographic recording layer contains several microholograms, where each microhologram is sized so that it can be read and written by an appropriate read-write optics (see also Figs 2,3 and 4) in a single, well defined static position. Normally, the microholograms are separated from each other physically, but they are all included in a single continuous holographic layer. The holographic chip also comprises semiconductor electronic elements, which are

all known by themselves, and they need not be discussed here. The electronic elements of the chip are connected to external devices through metallic electrical contacts, also known.

As it is shown in Fig. 1b, the holographic layer is positioned on the top surface of the microchip, in order to be optically accessible by a read-write optical system.

The holographic layer may be embedded in several other layers with different functions. In the embodiment shown in Fig. 1b, the following other layers are also present on the microchip:

First, there is an isolating/bonding layer directly on the microchip, which isolates thermally the holographic layer from the microchip.

Above the isolating layer there may be provided a heating layer. This may be formed as a fine wire mesh or with a conducting resistor layer. The purpose of this layer is an eventual moderate heating or more properly, tempering of the holographic layer, which performs best on a 30-40 °C operating temperature.

There is further provided a metallic or dielectric reflective layer or mirror between the holographic layer and the heating layer. This reflective layer or mirror is necessary for the so-called reflection polarisation holography, which is used as the recording method or recording technique with the holographic optical recording system of the invention. This recording method is described in detail in the International Publication No. WO 99/57719, which is herewith included by reference. The mirror may not be necessary for other types of holographic layers and recording techniques.

The holographic layer itself is enclosed between the mirror and a protecting layer. The protecting layer may also cover the edges of the other layers, as shown in Fig. 1b.

The holographic layer in this embodiment is an approx. 100 nm thick SCP layer, which may be fabricated very cost-effectively by spin-coating. The other layers are also prepared with known thin film or thick film technologies.

During the holographic recording with the most preferred optical system of the invention, the polarisation interference pattern is recorded in a photoanisotropic material as a spatially modulated optical anisotropy. For this purpose, the holographic layer is preferably a so-called Side Chain Polyester (SCP) material. In the recording process the molecules of the recording medium, e. g. a SCP compound, are aligned according to the polarisation of the incident light beam. The writing process utilises blue or green light, and the readout of the hologram is effected with red light. The recording process in e. g. azobenzene SCP material is described in detail in the publication "Side-chain Liquid Crystalline Polyesters for Optical Information Storage", in: Polymers for Advanced Technologies, Vol. 7, pp. 768-776., which is herewith included by reference. Similar materials suitable for holographic recording are also known, and may be used advantageously. The principles of polarisation holography are described in the publication "Polarisation holography. 1: A new high-efficiency organic material with reversible photoinduced birefringence", Appl. Opt., Vol. 23, No. 23, 1 December 1984, pp. 4309-4312, and the publication "Polarisation holography. 2. Polarisation holographic gratings in photoanisotropic materials with and without intrinsic birefringence", Appl. Opt., Vol. 23, No. 24, 15 December 1984, pp. 4588-4591.

It must be noted, however, that more traditional holograms may also be recorded on the chip, and the invention is not intended to be limited to polarisation holograms, though the best signal-to-noise ratios are achieved with this technique, if SCP material is used in the recording layer.
In an especially advantageous embodiment, the holographic layer is a liquid-crystal enhanced hologram, which will be described in detail with reference to Fig. 6.

In the most preferred embodiment, the microchip is a chip used for smart card applications. Such a card will be denoted here as a holographic chipcard.

Fig. 2 shows an improved holographic read-write optical system according to the invention. In order to achieve an even more compact, simple and less costly optical system, the read and write optics disclosed in the Patent Application HU P 98 01029 have been modified. According to the invention, the read and write optics includes a writing laser (typically a green or blue laser) and a reading laser (typically a red laser), which are brought together on a common optical axis by a wavelength selective beam splitter. Before this, the laser beams may be subjected to appropriate beam shaping, in order to achieve a uniform intensity distribution on the reference and the object. For this purpose, a diffraction array generator may be used, which creates N x N separate light beams of the original Gaussian distribution of the laser beams. In this way each pixel of the SLM is illuminated by a separate laser beam. These beams of the lasers are imaged on the pixels of an SLM (Spatial Light Modulator), which serves as an object and reference surface at the same time. The central region of the Gaussian beam is imaged on the reference region of the SLM. This novel arrangement allows the omission of a polarisation beam splitter and a compensator block, as compared with the optical system disclosed in HU P 98 01029. Since the compensator block is as large as a polarisation beam splitter, the novel arrangement of optical system of the invention may be made with two beam splitting elements only - typically glass or quartz cubes -, instead of four. Also, only one SLM is needed instead of two. Of course, the useful area of the SLM is reduced, but only a small fraction of the pixels is needed for the reference, and the rest may be utilised as the object, i. e. as the useful data.

However, the functions of a wavelength selective beam splitter and a polarising beam splitter has been united in a special central beam splitter shown in the centre of the optical system of Fig. 2a. This special central beam splitter is provided with a

polarisation selective surface as the diagonal splitting and reflecting surface, but in a central region of this diagonal surface there is a smaller region with a neutral beam splitting and reflecting surface. The two different splitting surfaces of the central beam splitter may be manufactured with a known masking technique. The central neutral splitting region is sized according to area reserved for the reference pixels on the SLM (See also Fig. 2b).

During writing, the green laser is used, in this embodiment on 532 nm wavelength. The beam is expanded, and it is imaged on the total area of the SLM, upon reflection from the diagonal reflecting surface. The central part of the SLM is defined as the reference surface, while the peripheral part is the object surface. The reference area is relatively small, e. g. 10 x 10 pixels. There is a l/2 plate before this area, which rotates the polarization of the incoming reference beam. The object area is larger, e. g. 256x256 pixels. The two areas are separated by a border, e. g. five pixels wide. All in all, one microhologram is capable of storing approx. 64 Kbits of data. This may be multiplied by a factor of 10 to 30, using some sort of multiplexing, e. g. phase coding. Considering a microchip with a top surface of 6 mm x 6 mm, there is enough place for 400 (20 x 20) microholograms, where each microhologram is sized 0.3 mm x 0.3 mm.

Upon reflection from the SLM, the beams are passing through the central beam splitter. and they are imaged on the hologram plate. One complete image of the SLM corresponds to one microhologram. The data stored in a microhologram are defined by the appropriate setting of the pixels in the object area, i. e. one pixel corresponds to one bit. The pixels rotate the polariztion direction of the incoming beam, or reflect them unchanged. This rotation (or the absence thereof) represent a binary 1 or 0. The reference pixels may be fixed in a uniform state, or they may be used for the purposes of the so-called phase-code multiplexing or phase encoding. This multiplexing technique is described in detail in the publication "Volume

hologram multiplexing using a deterministic phase encoding method", Opt. Comm. 85 (1991), pp. 171-176. In this case the pixels of the reference area must be used for defining mutually orthogonal vectors.

The wavelength of the read laser is preferably longer than the wavelength of the laser used for writing. On readout, the light of the reading laser is collimated by appropriate optics, so it is imaged only on the central region of the central beam splitter. The used wavelength in the embodiment shown is 635 nm. From there it is reflected towards the reference region of the SLM. After reflection on the reference region, the beam will function as the reference beam of the hologram readout. This reference beam is imaged through the imaging optics, a special Fourier lens, on one microhologram in the hologram layer. The reflected hologram is deflected in a larger angle due to the wavelength dispersion, (i. e. the difference between the refraction coefficients on the wavelength λ_1 of the write laser and the wavelength λ_2 of the read laser), and therefore the hologram is detected by the peripheral parts of the detector array. The beams of the reading laser is going straight through the central neutral beam splitting region are absorbed on a beam stop before the detector array, so the signal level of the detector is not impaired by the unmodulated central readout beam of the reading laser.

The optical system of Fig. 2 may be positioned by a known servo mechanism on the different microholograms in the holographic layer. This solution may be feasible for a holographic layer with a large area. However, the dimensions of the holographic layer are much smaller on a chip, and the distance between the microholograms is not very large. Therefore it is foreseen to provide the optical system of Fig. 2 with an optical positioning system instead of a mechanical one. Fig. 3 shows a possible embodiment of the optical positioning system. This system includes a scanning mirror arrangement between the polarising and detecting optics and the beam shaping optics of the read and write lasers (the red and green laser). When the

mirror is tilted in different angles, the image of the SLM will be projected on the different H1, H2, H3 microholograms of the hologram layer. Of course, this arrangement requires more costly imaging lenses, especially a larger Fourier lens. but the omission of a card or head positioning mechanism justifies the extra cost. It must be noted that a slightly larger central beam splitter is also necessary.

Fig. 4 shows a further embodiment of the optical system without a positioning mechanism. Here the scanning of the imaging beams are performed with the help of the variable LCD microprism array. The array includes a matrix of LC pixels, where each pixel functions as a miniature prism with a variable refractive angle. Such a device is described in the publication "Free-space optical interconnections with liquid-crystal microprism arrays" in Applied Optics, 10 May 1995, Vol. 34, No. 14. pp. 2571-2580. The microprism array allows the tilting of the reference and object beams reflected from the SLM in different angles, so that all microholograms on the chip are reached from one central position of the optical system.

Fig. 5 illustrates the block diagram of a holographic chipcard system of the invention. The holographic chip of the invention is integrated into a card, and thereby a holographic chipcard is created. The information contained in the holographic chipcard is stored partly in the microchip itself, and partly in the hologram on the chip. It is foreseen that the microchip mostly stores the program of the specific application, for which the holographic chipcard is used, e. g. program for banking functions or medical functions. Larger amounts of data are stored in the hologram on the chip. For enhanced security, the data in the hologram and in the chip may be encoded with some sort of encryption, and the information necessary for the decryption are stored in the other storage medium.

Returning to the system of the invention, this includes a combined optical and electronic read-write head for reading out the information from the hologram and the chip. respectively. The combined head includes electric contacts, and the necessary optics. The combined head, and within the head especially the beam scan

control unit, the CCD detector, the SLM and the lasers are controlled by a CPU. The CPU is in a bi-directional communication with external devices through an interface. Operational data and other information may be stored temporarily or permanently in a memory. There is provided a user interface, typically in the form of a display and a keyboard.

Fig. 6. shows a novel layer structure used for the holographic recording layer of the invention. This layer structure is termed as LC-enhanced holographic layer. It is essentially a traditional LCD-structure, where the LC (liquid crystal) is enclosed between two glass sheets. In the usual LCD-structures, the surfaces of the two glass sheets are directionally polished, and the polarisation direction of the LC material aligns itself along the polishing direction. Usually, the two glass surfaces are polished perpendicularly to each other, so there is a spiral-like twist in the polarisation direction within the LC material. There are also some LC materials where polarisation direction across the whole layer is turned in one well-determined direction. According to the invention, the holographic layer - which, in this case, is a layer suitable for polarisation holography - is inserted between one of the glass sheets and the LC material. This glass is not directionally, but homogeneously polished. Therefor, it is not going to affect the polarisation direction of the layer below it. Instead, the LC material will be now influenced by the holographic layer just adjacent to it, and the polarisation direction within the LC material - at least on its top surface - will be aligned to the polarisation direction of the holographic layer. This is illustrated in Fig. 6 with the area A and area B. In the area B, the polarisation direction of the holographic layer coincides with the polarisation direction of the bottom glass sheet, so in this area the incident light beam will not be modulated in the LC layer. In area A, the directions of the polarisation is perpendicular to each other, an therefore the incident light will be strongly modulated. The effect will be that the LC layer will enhance the polarisation effect within the combined stack of the holographic layer and LC layer, and a much better holographic diffraction

efficiency may be achieved with the same or almost the same energy. Further, the LC layer is more stable, and therefore it will increase the lifetime or the storage layer. With other words, the LC material will enhance the favourable optical properties of the holographic storage layer.

Claims:

1. A semiconductor-based microelectronic device, especially a microchip, characterised by comprising a holographic storage layer on its optically accessible surface, preferably on its top surface.

2. The device according to claim 1, characterised by that the holographic storage layer is a layer suitable for polarisation holography.

3. The device according to claim 1 or 2, characterised by that the holographic storage layer is an SCP layer.

4. A card provided with the microelectronic device according to any one of the claims 1 to 3, especially a smart card containing a holographic microchip.

5. An optical read-write system for a holographic layer suitable for polarisation holographic recording, comprising a read laser and a write laser, polarising optics. and a programmable display element, especially an SLM, for the purposes of modulating the object beam and the reference beam, characterised by using a single common two-dimensional programmable display element for the modulation of the reference and the object beams.

6. An optical read-write system for a holographic chip with a holographic layer for polarisation holographic recording, the optical system comprising a read and a write laser, polarising optics, and a programmable display element, especially an SLM, for the purposes of modulating the object beam and the reference beam, and a detector array for the readout of the information contained in the holograms of the holographic layer, where an image of the programmable display element is recorded in a polarisation recording medium as a single microhologram, and further the

optical read-write system comprising positioning means for positioning the image of the programmable display element in different positions in the holographic recording layer, characterised by that the positioning means are comprising beam scanning means for the purposes of recording and accessing differently located microholograms in the holographic layer.

7. The optical read-write system according to claim 6, characterised by that the beam scanning means comprises a scanning mirror.

8. The optical read-write system according to claim 6, characterised by that the beam scanning means comprises a variable liquid crystal microprism.

9. A holographic recording layer structure, especially a layer structure containing an SCP holographic layer, characterised by the provision of a heating layer in the vicinity of the holographic layer, in order to heat the holographic layer to optimal operation temperature.

10. A holographic recording layer structure for polarisation holography, especially a layer structure containing an SCP holographic layer, characterised by comprising a homogeneously polished glass sheet, a directionally polished glass sheet, and a liquid crystal layer positioned between the two glass sheets, and further the holographic recording layer positioned between the liquid crystal layer and the homogeneously polished glass sheet, and further the directionally polished glass layer positioned on the other side of the liquid crystal layer.

11. A holographic chipcard system, comprising a card with an embedded microelectronic device according to any one of the claims 1 to 3, and further comprising a holographic read-write optical system according to any one of the claims 6 to 8.

Fig. 1a

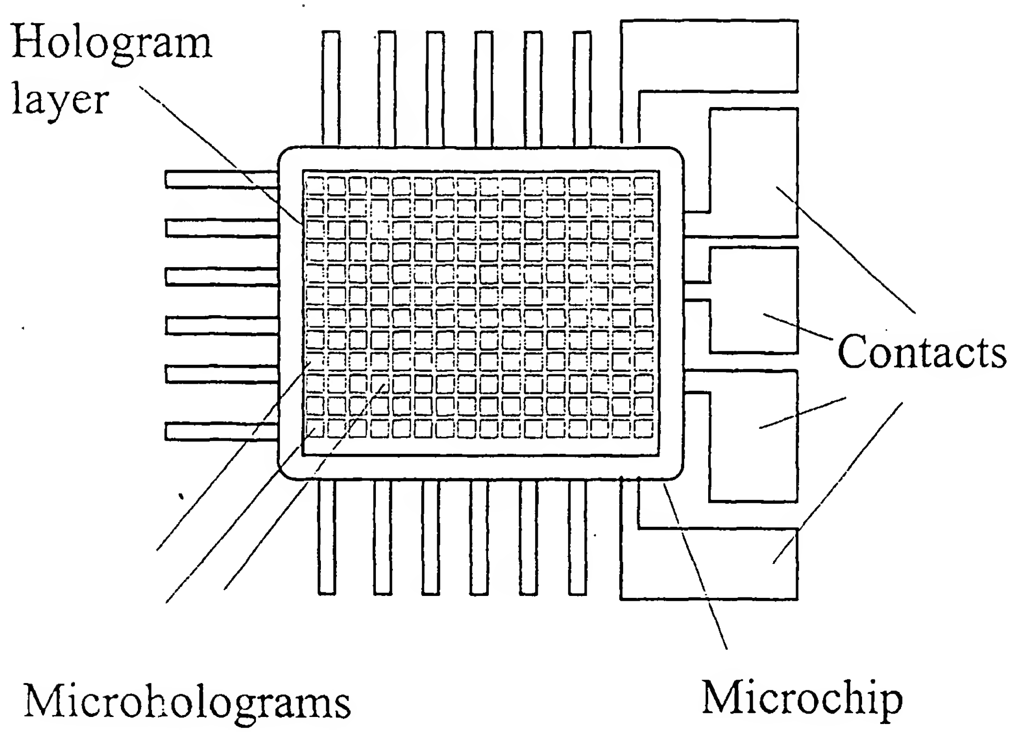
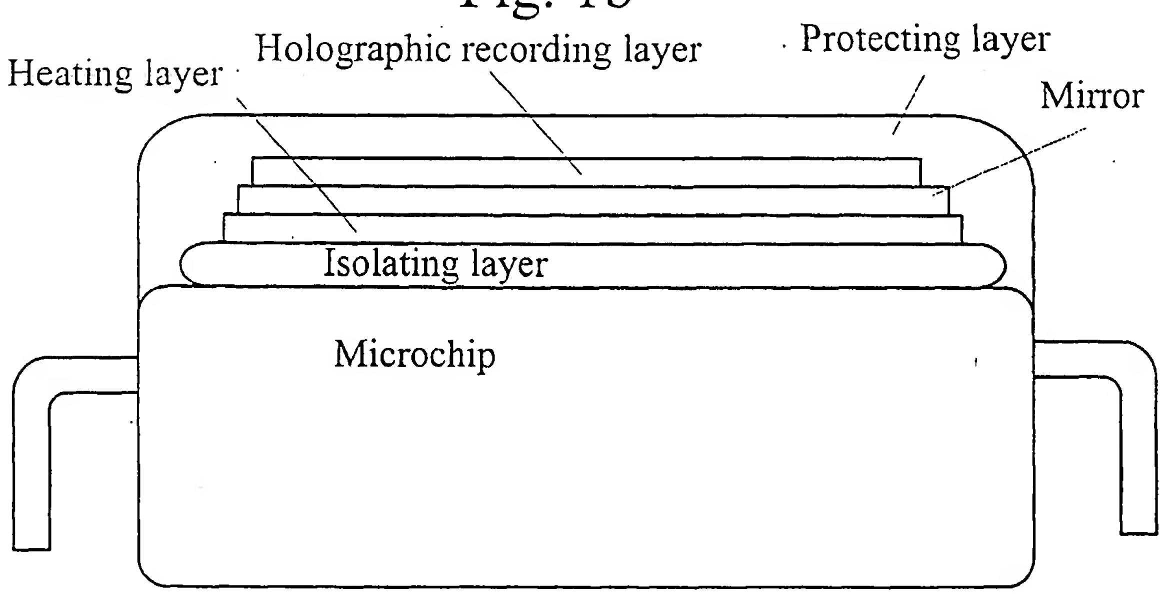

Hologram layer
Contacts
Microholograms
Microchip

Fig. 1b


Holographic recording layer
Protecting layer
Heating layer
Mirror
Isolating layer
Microchip

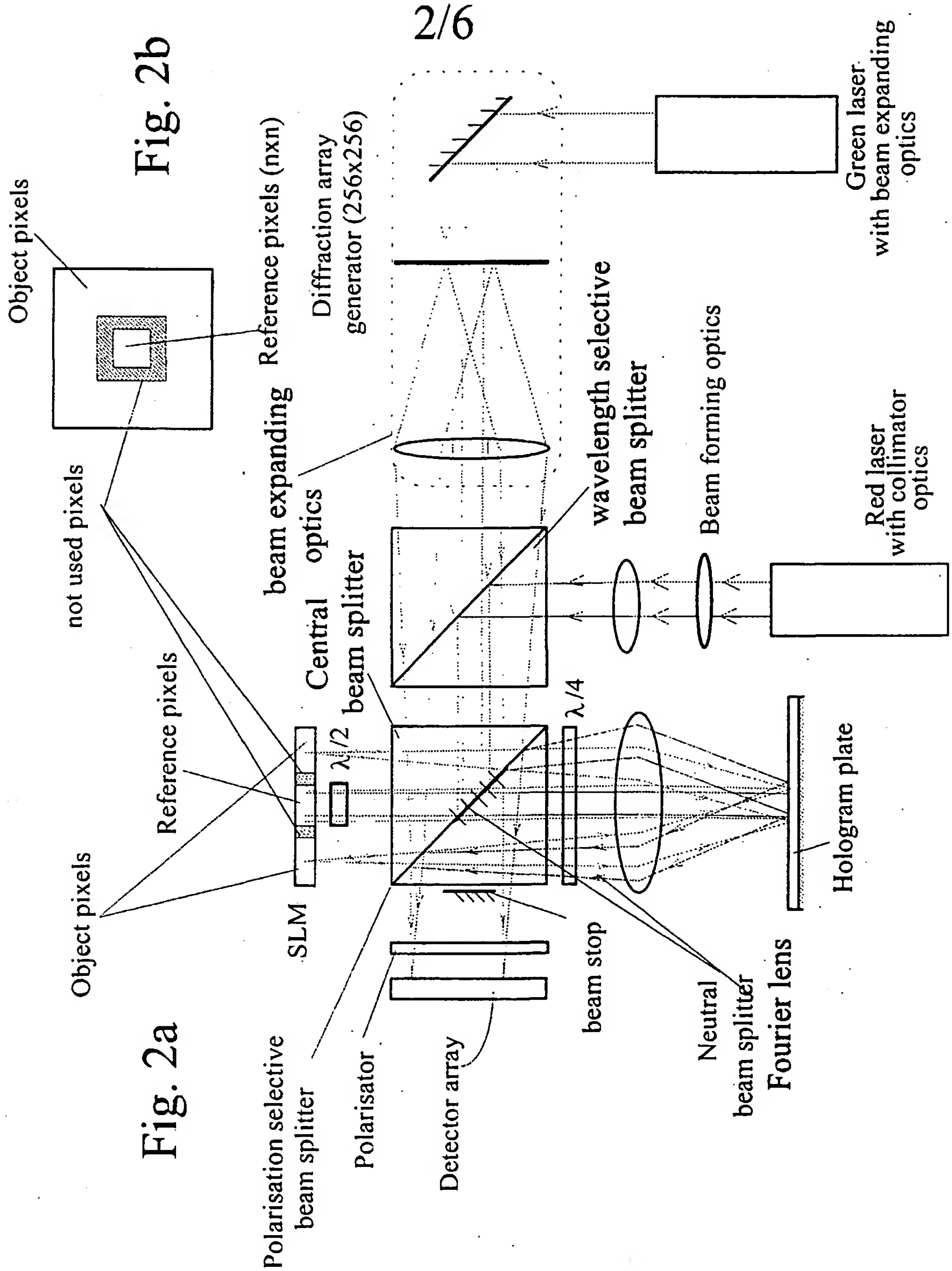

Object pixels
Reference pixels (nxn)
not used pixels
Diffraction array generator (256x256)
Green laser with beam expanding optics
beam expanding optics
wavelength selective beam splitter
Beam forming optics
Red laser with collimator optics
Central beam splitter
Reference pixels
Object pixels
SLM
λ/2
λ/4
Hologram plate
Polarisation selective beam splitter
Polarisator
Detector array
beam stop
Neutral beam splitter
Fourier lens

Fig. 2b

Fig. 2a

Fig. 3

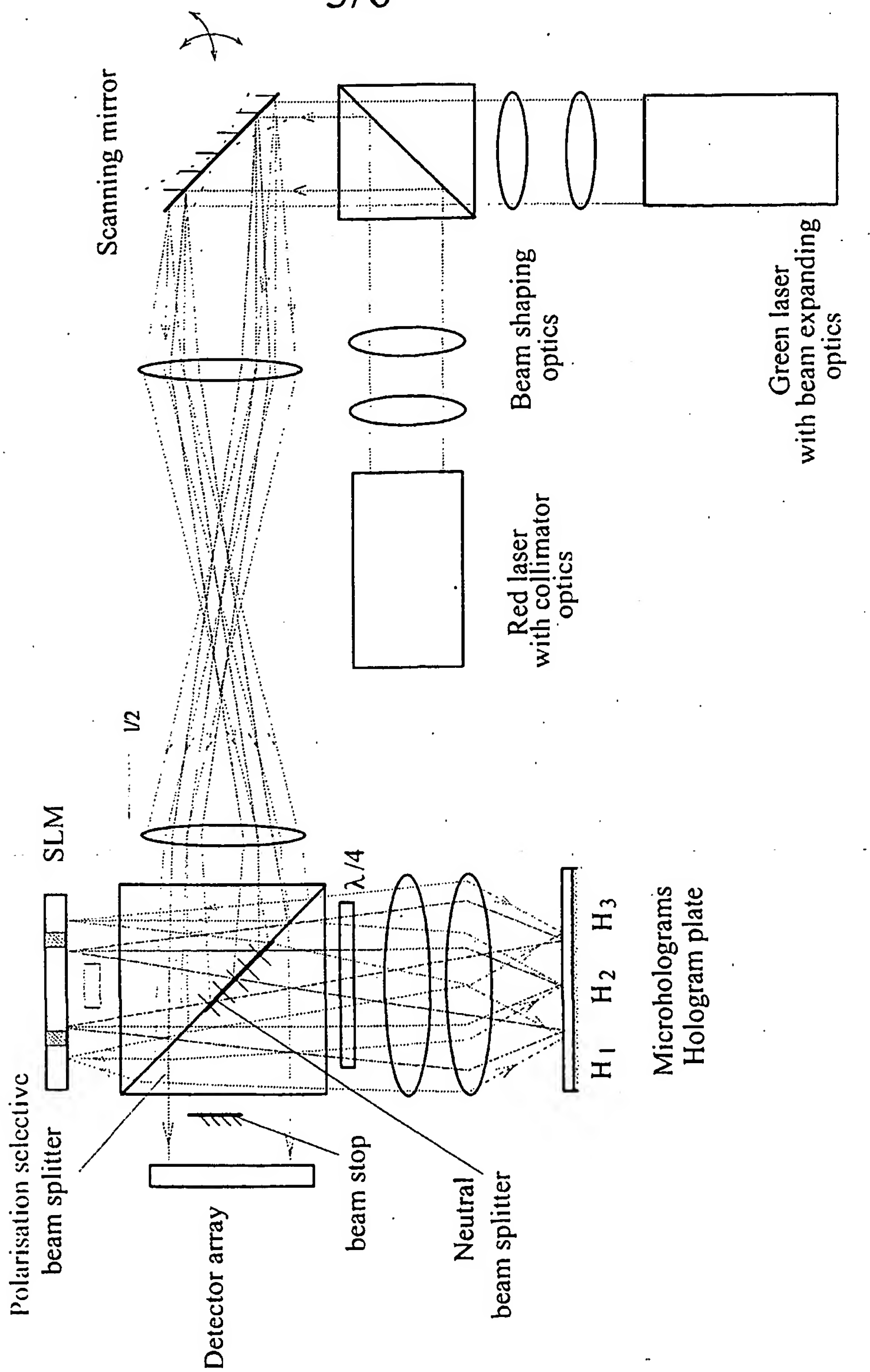
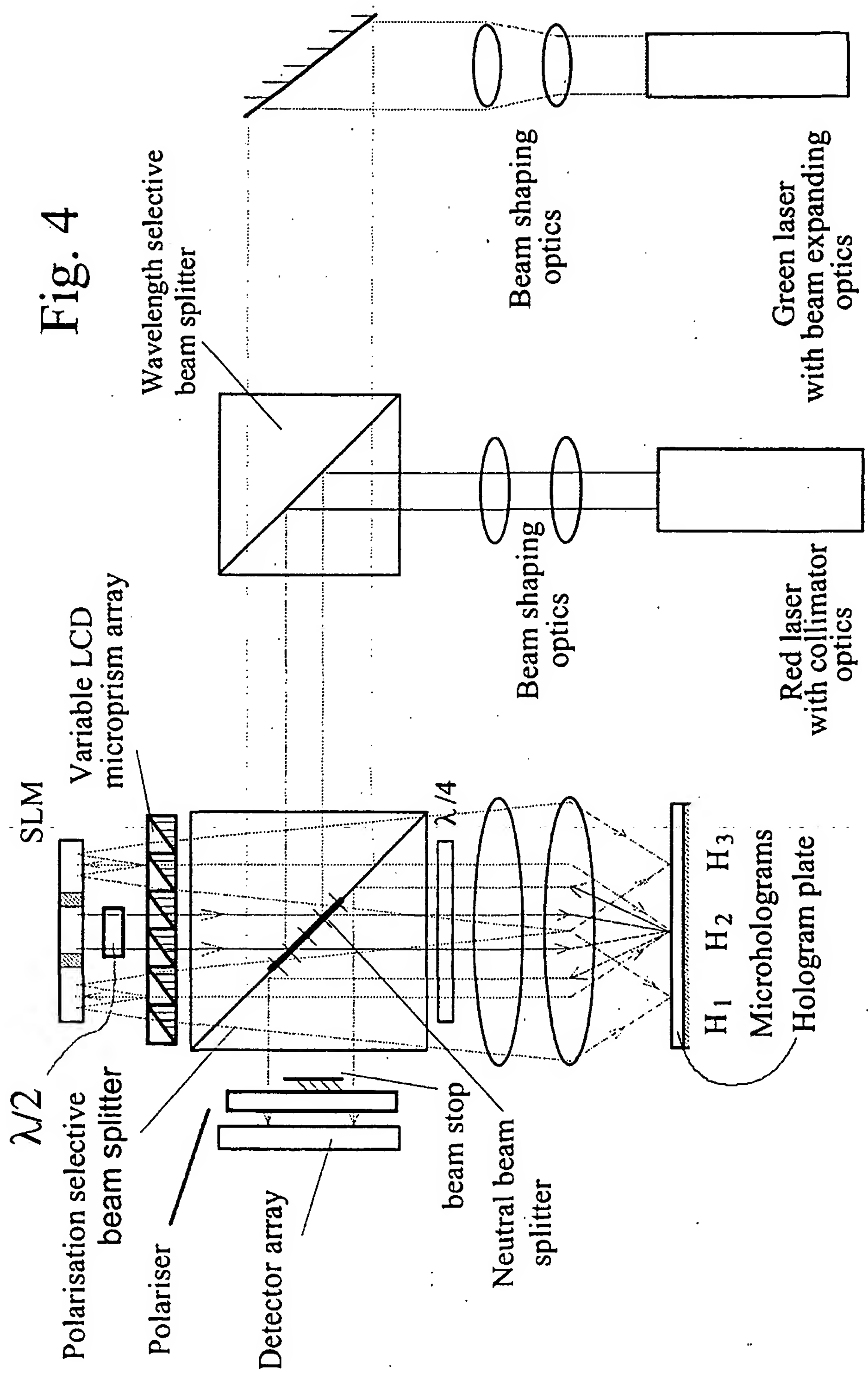

Scanning mirror
Beam shaping optics
Green laser with beam expanding optics
Red laser with collimator optics
1/2
SLM
λ/4
H1 H2 H3
Microholograms
Hologram plate
Polarisation selective beam splitter
Detector array
beam stop
Neutral beam splitter

Fig. 4


Wavelength selective beam splitter
Beam shaping optics
Green laser with beam expanding optics
Variable LCD microprism array
SLM
Beam shaping optics
Red laser with collimator optics
λ/4
λ/2
Polarisation selective beam splitter
Polariser
Detector array
beam stop
Neutral beam splitter
H1 H2 H3
Microholograms
Hologram plate

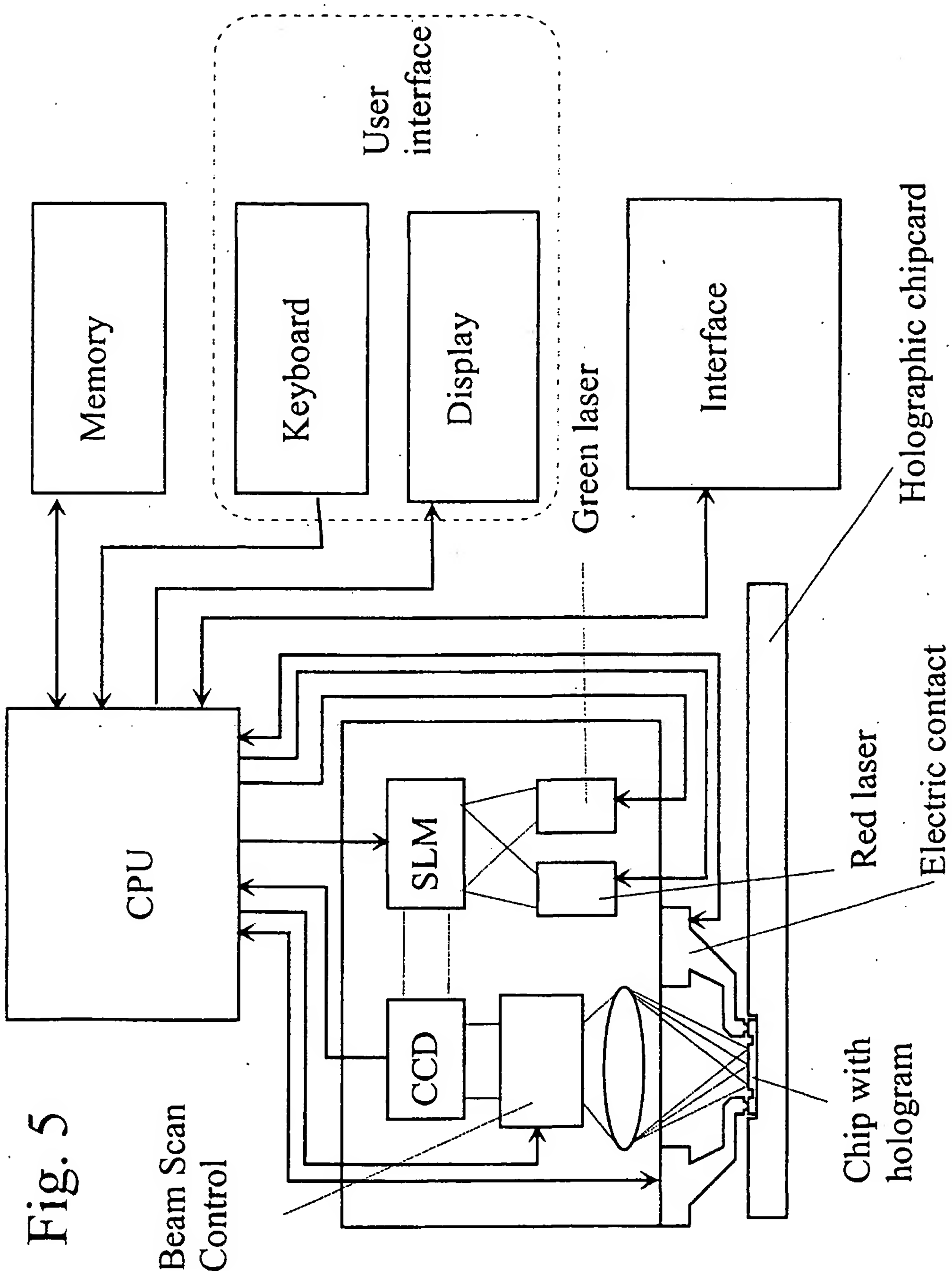

User interface
Memory
Keyboard
Display
Interface
Green laser
Holographic chipcard
CPU
SLM
CCD
Red laser
Electric contact
Chip with hologram
Beam Scan Control

Fig. 5

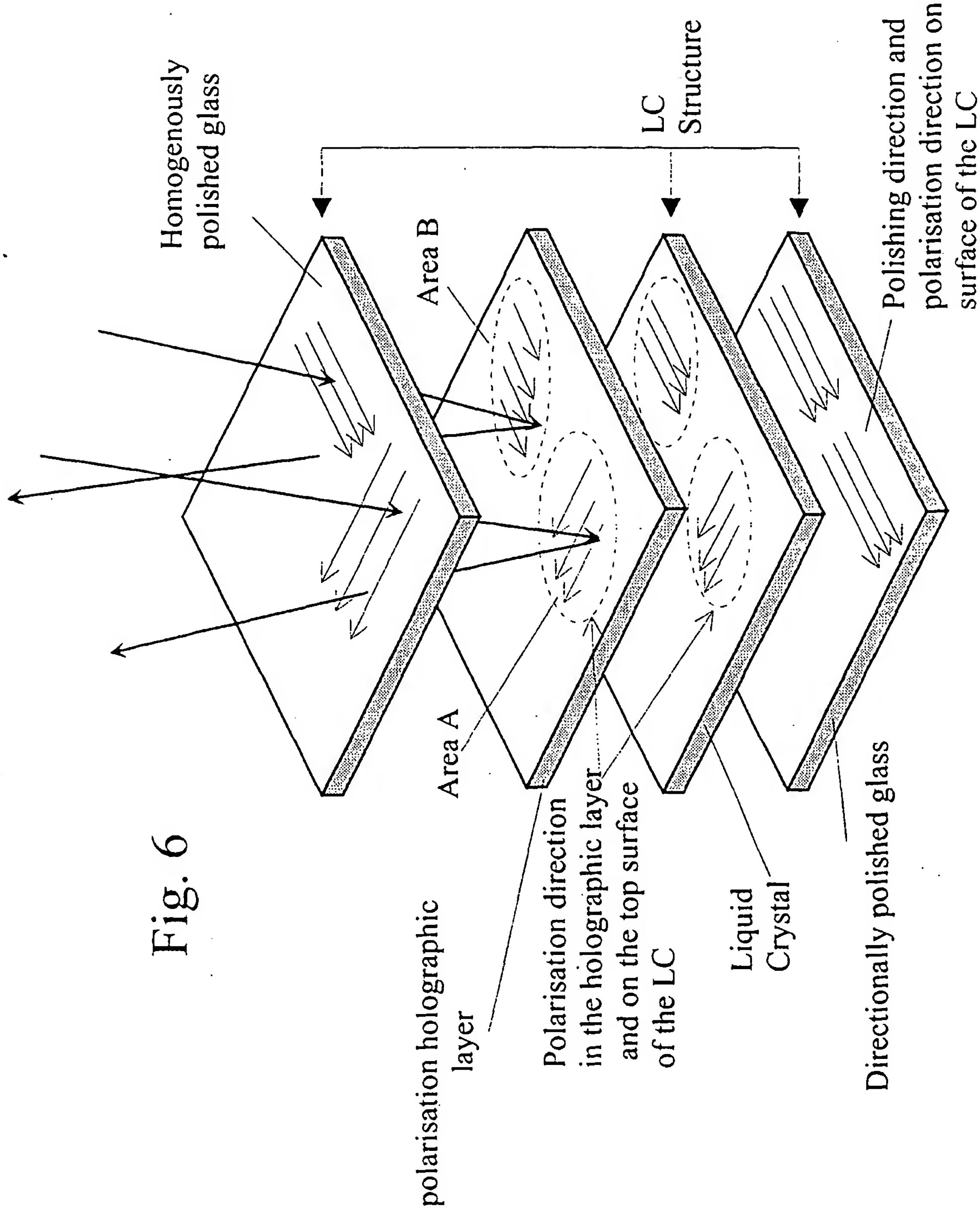

Homogenously polished glass
LC Structure
Area B
Area A
Polishing direction and polarisation direction on the bottom surface of the LC
polarisation holographic layer
Polarisation direction in the holographic layer and on the top surface of the LC
Liquid Crystal
Directionally polished glass

Fig. 6

INTERNATIONAL SEARCH REPORT

Inte[illegible]onal Application No
PCT/HU 99/00088

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G03H1/02 G06K19/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G03H G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 02849 A (AUSTRIA CARD ;PRANCZ MARKUS (AT)) 22 January 1998 (1998-01-22) page 6, line 27 -page 7, line 31 figures	1
Y		2-4

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 March 2000	20/03/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Krametz, E

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	RAMANUJAM P S ET AL: "SIDE-CHAIN LIQUID CRYSTALLINE POLYESTERS FOR OPTICAL INFORMATION STORAGE" POLYMERS FOR ADVANCED TECHNOLOGIES,GB,JOHN WILEY AND SONS, CHICHESTER, vol. 7, no. 9, 1 September 1996 (1996-09-01), pages 768-776, XP000625573 ISSN: 1042-7147 cited in the application page 768, left-hand column, paragraph 1 -page 770, right-hand column, paragraph 1 page 774, left-hand column, paragraph 3 -page 775, left-hand column, paragraph 1	2,3
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A	WO 97 02563 A (YENPLOY PTY LTD ;MARTIN DONNA KOURTESSIS (AU); FARUQI FARHAN AHMED) 23 January 1997 (1997-01-23) page 1, line 4 - line 8 page 4, line 13 - line 17 page 11, line 6 - line 28 claims 1-3	5,6
A	US 5 671 073 A (BARBASTATHIS GEORGE ET AL) 23 September 1997 (1997-09-23) column 4, line 15 -column 5, line 20 figure 1	5,6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/HU 99/00088

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			EP	0912962 A	06-05-1999
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